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MOORA and SWARA collective MCDM approach for Smartphone Selection

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ABSTRACT

In this paper, collective MOORA and SWARA multi criteria decision making approach is applied to evaluate various alternatives of Smartphone available on online shopping websites. Smartphone Selection is classified as multi criteria decision making problem, Selection is based on various qualitative and quantitative features used for evaluation for numerous alternatives available. In this study various features of Smartphone are defined as per user preferences and based on budget five different Smartphone models are selected from online shopping website. To evaluate selected five phones user preferred features were classified into qualitative and quantitative features. Later collective approach was applied to demonstrate effectiveness in multi criteria decision making process. MOORA was applied to rank various Smartphone alternatives based on quantitative features and SWARA to rank based on qualitative features. The rank score for qualitative and quantitative is collected together to decide best Smartphone among selected five Smartphone.

1. Introduction

Mobile is most preferred communication device used to communicate from one part of world to the other part of world. As technology is transforming, users also started shifting their preference from basic feature phone to Smartphone. Smartphone is term that differentiate basic feature phone from highly sophisticated advanced feature phones. Smartphone provide integrated services which includes voice communication, text messaging, personal information management, web browsing, data management, third party application support, photo shut, gaming and services which make Smartphone as means of entertainment and also 24x7 wallet service (Davey and Davey, 2014). To make 24x7 wallet service most of Smartphone's are emerging with various operating systems, such as android, iPhone IOS, Microsoft window, bada, blackberry OS, symbian, webOS, ubuntu and firefox. The operating system of any Smartphone mainly decides ease of use along with support to other application like web browsing, gaming, multiprocessing, GPS support, security against malware, virus etc. (Bala et.al., 2015). Along with operating system other feature like RAM, battery, talk time, stand by time, internal memory, weight, thickness, screen size, processor type, cost, aesthetic, durability, built quality decides performance of Smartphone and also selection by user(Yildiz and Ergul, 2015). To cater user's requirements Smartphone provider strive to improve Smartphone features on continuous time line. Once Smartphone features are enhanced, they are launched in the market with different names or different series on periodic basis. Market with vast Smartphone brands, names, series and diverse preferred features by user make Smartphone selection process complex. Selection complexity increases when features are conflicting in nature. Smartphone, selection is based on consideration of various feature requirements which sometime conflicting nature and due considering numerous selection alternatives available in market, complex Smartphone selection process can be classified into multi criteria decision making problem.

Smartphone selection decision is long term decision and complex with numerous feature and alternatives. In this study collective MOORA and SWARA multi criteria decision making method is employed to select best Smartphone. Study provides selection process not limited to Smartphone but for other selection process, which involves qualitative and quantitative selection features, and with many alternatives available.

2. Problem In Hand

In this paper collective MOORA and SWARA multi criteria decision, making approach is suggested to problems with multiple alternative options, with qualitative and quantitative selection features. To demonstrated application of approach Smartphone buyer was identified. For this purpose, meetings are held with buyer to identify needs, requirements and allocated budget amount to carry out selection of Smartphone. Later buyer requirements are classified into qualitative and quantitative features for alternative evaluation purpose using suggested approach.

3. Literature Review

Decision making is rational process and sometime requires selection of competitive alternative from set of alternatives taking into consideration advantages and disadvantages of individual alternatives (Vahdani et. al., 2014). Decision making with one objective generally concern with either minimization or maximization and such problems are classified as linear or non-linear problems. The Multi Criteria Decision Making (MCDM) is branch of Operation Research that deals with decision making under presence multiple decision criteria's (Kumar et.al. 2017). These criteria's are often conflicting in character, MCDM aids in collecting and judging multiple criteria in order to rank or select alternatives from group of alternatives. With one objective problem some selection criteria's are omitted or their vagueness is not considered in decision making. In MCDM, all decision criteria's are taken into account while making decision, decision maker evaluates all available alternatives and ranks them based on features (Mirzaei et.al., 2015). MCDM methods are classified into MADM and MODM methods (Patil, 2018). MCDM process follows three steps. First defining criteria's and alternatives, next attaching numerical values to criteria's which assist in evaluating alternatives and last process numerical value to rank alternatives (Mulliner et. al., 2013). Different methods are devised for solving MCDM problems which includes ELECTRE, AHP, TOPSIS, ANP, VIKOR, COPRAS, GRA, MOORA, SWARA, MUSA, AKUTA, PROMETHE, SAW, FARE (Mirzai et. al.,2015, Patil and Prajapati, 2017, Zolfani and Saparauskas, 2013)

AHP, ANP, FARE, SWARA are weight assessment famous approaches and among all SWARA is most simple method. In weight assessment approaches expert plays crucial role in allocating weights to individual criteria's. Most important criteria's are given more weight and least important are given less weight. Individual alternatives are later evaluated and ranking is assigned. SWARA method is less complicated among others and expert can work easily with method. Method has advantage if priorities are readily defined (Zolfani and Saprauskas, 2013). SWARA method was first introduced in 2010 in multi attribute decision making field (Zolfani et. al., 2018). The SWARA method is most useful in decision making and policy framing by top management decision makers. The method has vast application which includes product design, mechanical application decision, online games success factors investigation, market segmentation and selection, machine tool selection, etc. (Ghorshi et. al, 2015). SWARA method is based on five steps. In the first step criteria's are sorted in descending order based on preference. In the second step nth criteria is compared with (n-1)th criteria to determine comparative importance value Sj. In the next steps it calculates comparative coefficient (kj), weight (qj) and relative weight (Wj) using equation (1), (2) and (3) respectively for each criteria.

$$kj = \begin{cases} 1 & j=1 \\ Sj + 1 & j>1 \end{cases} \quad (1)$$

$$qj = \begin{cases} 1 & j=1 \\ qj -1 / kj & j>1 \end{cases} \quad (2)$$

$$Wj = qj / \sum qj \quad (3)$$

The MOORA, multi objective optimization uses ratio analysis method. It considers both benefits and efforts criteria for ranking and selecting best alternative among set of alternatives. Multi objective problems are found in various field including product design, process design, finance, aircraft design, oil industry, manufacturing sector, automobile sector, or fields where decision is taken based on trade off between conflicting criteria's (Chakraborty, 2011). Benefit criteria requires maximization and efforts criteria requires minimization. These criteria's are conflicting in nature while selecting best alternative. These adds complexity to selection procedure. MOORA method assists selection process by incorporating ratio analysis in process (Karande and Chakraborty, 2012). The MOORA method consist of two components i) ratio system and ii) reference point approach. In ratio system numeric value of criteria corresponding to individual alternative is compared to an denominator which is representation of all alternatives. In reference point ratio calculated in first component of MOORA is used to determine maximum numeric value of criteria of individual alternative (Brauers et. al., 2018). In MOORA comparison between numerator and denominator is calculated using equation (4) and reference point considering maximization and minimization is calculated using equation (5).

$$C^*_{ij} = \frac{C_{ij}}{\sqrt{\sum_{j=1}^{m} C_{ij}^2}} \quad (4)$$

$$W_j^* = \sum_{Max} C_{ij}^* - \sum_{Min} C_{ij}^* \quad (5)$$

Cij* is Numerical value of each quantitative criteria for individual m alternatives and Wj* weight of individual alternative.

4. Smartphone Selection

To demonstrate application of devised methodology, Smartphone selection is done with help of Smartphone buyer in Goa, India. Buyer was in plan to purchase Smartphone with budget amount of INR 12500. As a preliminary study discussion was carried out with buyer to know needs and requirement to identify features which needs to be focused upon while selection. Discussion concluded build quality (C1), screen size (C2), resolution (C3), processor type (C4), operating system (C5), ram (C6), front camera (C7), rear camera (C8), battery (C9), internal storage (C10), expandable memory (C11), thickness (C12), weight (C13), sensors (C14), Cost (C15) as important selection features. Build in quality is important as it decides durability of Smartphone. Build is either steel, plastic or glass type. Usage of Smartphone defines Size and resolution, video streaming, photography, browsing required bigger size screen and higher resolution. Processor, operating system and ram govern speed of Smartphone. Rear and front camera is important for users who enjoy photography and very much concern about quality of photos. Battery decides usage, capacity needs higher for heavy usage and average capacity for light users. Detail study of all features and brainstorming discussion with user aided in finalizing priority of features. To make analysis more effective priority ranking is converted into weighted score using linear weight with variable slope model (Alfares and Duffuaa, 2006). Equation (6) and (7) are used to calculate priority weighted score. The ranking and priority weighted score for each criteria' is as presented in Table1.

$$W_r = 100 - S_n(r-1) \quad (6)$$

$$S_n = 3.19514 + \frac{37.75756}{n} \quad (7)$$

Wr is priority weighted score, r is priority of each criteria and n is total number of criteria's

Survey of available Smartphone was carried out on one of the well know online shopping website in India. Based on studies five different Smartphone were decided for further analysis using collective approach. Data relevant to selection features was collected from online shopping website and tabulated as shown is Table 2. Later selected five, different Smartphone SP1, SP2, SP3, SP4 and SP5 were evaluated independently for their qualitative and quantitative features to rank them based on score. Further score was collected together to decide final score.

Table 1. Priority Weighted Score

Criteria	C1	C2	C3	C4	C5	C6	C7	C8	C9	C10	C11	C12	C13	C14	C15
Priority	2	3	9	6	7	11	13	14	10	8	12	5	4	15	1
Priority Weighted Score	0.94	0.88	0.54	0.71	0.66	0.43	0.31	0.26	0.49	0.60	0.37	0.77	0.83	0.20	1

Table 2. Preliminary Data Collection

Criteria	SP1	SP2	SP3	SP4	SP5
C1	Good	Average	Average	Medium	Good
C2	15.21	14.83	15.24	15.8	15.21
C3	Full HD+, 2160 x 1080 Pixels	2280 x 1080 Pixels	HD+, 720 x 1480 Pixels	HD+, 1520 x 720 Pixels	2160 x 1080 Pixels
C4	Qualcomm Snapdragon 636	Kirin 659 Octa Core Processor	Qualcomm Snapdragon SD425	MT6762 (Helio P22) Processor	Qualcomm Snapdragon 636
C5	Android Nougat 7.1.2	Android Oreo 8	Android Oreo 8.1	Android Oreo 8.1	Android Oreo 8.1
C6	4	4	4	4	4
C7	20	16	8	5	5
C8	12	13	13	13	13
C10	4000	3000	3300	3260	5000
C11	64	64	64	32	64
C12	8.05	7.7	8	7.77	8.46
C13	181	152	178	148	180
C14	Fingerprint Scanner, Ambient Light Sensor, Proximity Sensor, E Compass, Accelerometer, Hall Sensor, Gyroscope	Fingerprint Sensor, Proximity Sensor, Ambient Light Sensor, Compass, Gravity Sensor, Phone Status Indicator	Accelerometer, Fingerprint Sensor, Gyro Sensor, Geomagnetic Sensor, Light Sensor, Proximity Sensor	Accelerometer, Ambient Light Sensor, Proximity Sensor, E-compass, Fingerprint Sensor, Virtual Gyroscope	Accelerometer Sensor, E-Compass, Proximity Sensor, Ambient Light Sensor, Rear Fingerprint Sensor, Gyroscope
C15	12999	10999	12990	12490	11999

Table.3. Build Quality

Smartphone	Sj	kj	qj	Wj	Final Weight
SP1		1	1	0.2089	0.196
SP5	0	1	1	0.2089	0.196
SP4	0.15	1.15	0.8696	0.1816	0.171
SP2	0.2	1.2	0.9583	0.2002	0.188
SP3	0	1	0.9583	0.2002	0.188

Table 4. Resolution

Smartphone	Sj	Kj	qj	Wj	Final Weight
SP2		1	1	0.2617	0.141
SP1	0.2	1.2	0.8333	0.2181	0.118
SP5	0	1	0.8333	0.2181	0.118
SP4	0.3	1.3	0.6410	0.1678	0.091
SP3	0.25	1.25	0.5128	0.1342	0.072

Table 5. Processor

Smartphone	Sj	kj	qj	Wj	Final Weight
SP1		1	1	0.2635	0.187
SP5	0	1	1	0.2635	0.187
SP2	0.4	1.4	0.7143	0.1882	0.134
SP4	0.15	1.15	0.6211	0.1636	0.116
SP3	0.35	1.35	0.4600	0.1211	0.086

Table 6. Operating System

Smartphone	Sj	kj	qj	Wj	Final Weight
SP3		1	1	0.2307	0.152
SP4	0	1	1	0.2307	0.152
SP5	0	1	1	0.2307	0.152
SP2	0.1	1.1	0.7142	0.1647	0.109
SP1	0.15	1.15	0.6211	0.1433	0.095

Table 7. Sensors

Smartphone	Sj	kj	qj	Wj	Final Weight
SP1		1	1	0.2191	0.044
SP2	0.1	1.1	0.9091	0.1991	0.040
SP3	0.02	1.02	0.8912	0.1952	0.039
SP4	0.01	1.01	0.8824	0.1933	0.039
SP5	0	1	0.8824	0.1933	0.039

Table 8. SWARA Weight

Criteria	C1	C3	C4	C5	C14	SWARA Weight
Smartphone						
SP1	0.196	0.118	0.187	0.095	0.044	0.64
SP2	0.188	0.141	0.134	0.109	0.040	0.612
SP3	0.188	0.072	0.086	0.2307	0.039	0.6157
SP4	0.171	0.091	0.116	0.2307	0.039	0.6477
SP5	0.196	0.118	0.187	0.152	0.039	0.692

Analysis was carried on collected data for qualitative ranking using SWARA approach in consultation with expert to determine relative weights of individual Smartphone. Relative weight for each feature for all models is calculated and tabulated as in Table from 3 to 7. Final weight of each Smartphone relative to feature is calculated as product of relative weight and priority weighted score. Final Ranking of Smartphone is presented in Table 8. Final ranking is calculated as sum score of final weight for each feature. Table 8. shows SP5 is having highest score whereas SP2 is having least score.

Later MOORA approach was used, to determine ranking of each Smartphone, considering quantitative features. From ten qualitative features C12, C13 and C15 needs minimization whereas C2, C6, C7, C8, C9, C10, C11 requires maximization. Table 9 shows results of MOORA. SP5 is having highest score whereas SP4 is having least score.

Smartphone score obtained from SWARA and MOORA are collected together to decide best Smartphone. Table 10 shows collective score of Smartphone. If score of Smartphone is considered only for qualitative and quantitative criteria then variation is very reasonable, but if total score is considered then variation is significant. From table 10 we can infer that SP5 is having highest score and SP4 having lowest score. Considering qualitative and quantitative features SP5 is best Smartphone among selected five Smartphone's. Buying SP5 will be the best deal for buyer fulfilling all needs and requirement identified during initial phase of study.

Table 9. MOORA Score

Criteria	C2	C6	C7	C8	C9	C10	C11	C12	C13	C15	MOORA Weight
Priority	3	11	13	14	10	8	12	5	4	1	
Weight	0.88	0.43	0.31	0.26	0.49	0.60	0.37	0.77	0.83	1	
	Max	Max	Max	Max	Max	Max	Max	Min	Min	Min	
Smartphone											
SP1	0.4457	0.4472	0.7207	0.4190	0.4729	0.4850	0.0609	0.4499	0.4805	0.4719	0.2449
SP2	0.4345	0.4472	0.5766	0.4539	0.3547	0.4850	0.1219	0.4304	0.4035	0.3993	0.3157
SP3	0.4465	0.4472	0.2883	0.4539	0.3902	0.4850	0.2438	0.4471	0.4726	0.4716	0.1568
SP4	0.4630	0.4472	0.1801	0.4539	0.3854	0.2425	0.1219	0.4343	0.3929	0.4534	0.0391
SP5	0.4457	0.4472	0.1801	0.4539	0.5912	0.4850	0.9524	0.4729	0.4779	0.4356	0.4950

Table 10.. Final Score of Smartphone's

Smartphone	SWARA Weight	MOORA Weight	Total Score
SP1	0.64	0.2449	0.8849
SP2	0.612	0.3157	0.9277
SP3	0.6157	0.1568	0.7725
SP4	0.6477	0.0391	0.6868
SP5	0.692	0.4950	1.1870

5. Conclusion

In this study, a collective approach is formulated to select best alternative among set of alternatives, where selection of alternatives is based on quantitative and qualitative feature. The devised approach is best suitable for multi criteria decision-making problems. In collective approach, MOORA and SWARA methods are used and combined together to evaluate qualitative and quantitative features. The collective approach was demonstrated on Smartphone selection for buyer in India. Smartphone selection is multi criteria problem considering qualitative and quantitative features as defined by buyer. Score of each alternative is observed less significant if individual qualitative and quantitative criteria's are considered for evaluation. But, when qualitative and quantitative are collected together score found significantly different. From study we can conclude multi criteria problems need in depth evaluation to avoid wrong decision while selecting alternatives. SWARA and MOORA approach is best suitable for multi criteria decision with qualitative and quantitative decision making features.

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